COMPLETE LISTING OF CLAIMS IN ASCENDING ORDER WITH STATUS INDICATOR

1.-20. (Cancelled)

21. (Currently amended) A method of making a soft metal conductor for use in a semiconductor device which comprises depositing a first layer of said soft metal consisting of grains having grain sizes not less than [[200 nm]] 0.3μm; and further comprising depositing a layer of said soft metal consisting of grains having a grain size of not more than 50 nm and a layer thickness of not less than 400 nm prior to said deposition process of said first layer of soft metal so as to provide a substantially scratch-free surface upon polishing in a subsequent CMP step.

22. (Original) A method according to claim 21, wherein said first soft metal layer is deposited by a technique selected from the group consisting of physical vapor deposition, chemical vapor deposition, evaporation and collimation.

23. (Cancelled)

24. (Previously presented) A method according to claim 21, wherein said first soft metal layer has a thickness of at least 100 nm.

25. (Cancelled)

26. (Original) A method according to claim 21 further comprising the steps of sequentially depositing a layer of Ti of less than 30 nm thick and a second layer of soft metal on top of said first soft metal layer such that the anti-electromigration property of said soft metal conductor is improved when said Ti layer is converted to $TiAl_3$ layer in a subsequent annealing process.

27. (Original) A method according to claim 21, wherein said soft metal is selected from the group consisting of Al, Cu, Ag, CuAg, CuAl, AgAl, and CuAgAl.

28. (Original) A method of making a soft metal conductor in a semiconductor device comprising the steps of:

filling a cavity for conductor with a soft metal at a first temperature between about 100°C and about 300°C, said soft metal consisting of metal grains having a first grain size, and

heating said conductor to a second temperature and for a length of time sufficient to grow said metal grains to a second grain size larger than said first grain size.

29. (Original) A method according to claim 28, wherein said conductor is a member selected from the group consisting of a via, and interconnect and a line.

30. (Original) A method according to claim 28, wherein said soft metal is selected from the group consisting of Al, Cu, CuAg, CuAl, AgAl and CuAgAl.

31. (Original) A method according to claim 28, wherein said second temperature is not less than 300°C and said length of time is 2 min.

32. (Original) A method according to claim 28, wherein said second grain size is larger than said first grain size such that the polishing characteristics of said soft metal conductor is improved.

33. (Original) A method according to claim 28, wherein said second grain size is not smaller than 200 nm.

34. (Original) A method according to claim 28, wherein said first grain size is not larger than 200 nm and said second grain size is not smaller than 200 nm.

35. (Original) A method of polishing a soft metal structure according to a predetermined polishing process defined by the equation of:

$$\frac{dV}{dt} = \frac{KAR_{pd}H_pV_cG_p}{H_mG_m}$$

wherein dV/dt is the rate the volume of metal is removed, H_m is the hardness of the metal, H_p is the hardness of the particles in the slurry, A is the area of metal exposed, G_m is the grain size of metal, G_p is the grain size of the particles in the slurry, R_{pd} is the roughness of the polishing pad, K is the constant that depends on the chemical bonds between particles, metal, pad, and pH factor, and V_c is the speed of the chuck, whereby said method allows an optimum volume of metal to be removed without scratching or R_{pd} erosion occurring in the metal.

36. (Original) A method according to claim 35, wherein the soft metal structure is a member selected from the group consisting of a via, and interconnect and a line.

37. (Original) A method according to claim 35, wherein said soft metal is selected from the group consisting of Al, Cu, Ag, CuAg, CuAl, AgAl and CuAgAl.

38. (Original) A method according to claim 35, wherein G_m is not smaller than 200 nm.

39. (Previously presented) A dual-step deposition method for making a soft metal conductor for use in an electronic device comprising:

depositing a first layer of metal by a physical vapor deposition process to a first thickness, and

depositing a second layer of metal on top of said first layer of metal to a second thickness larger than said first thickness by a method selected from the group consisting of chemical vapor deposition, electroplating and electroless plating; and

wherein said first and said second metal layer are deposited of a material selected from the group consisting of Al, Cu, Ag, CuAl, CuAg, AgAl, and CuAgAl.

40. (Cancelled)

41. (Original) A dual-step deposition method for making a soft metal conductor according to claim 39, wherein said second metal layer deposited has an average grain size of not smaller than 0.1 μm.

42. (Original) A dual-step deposition method for making a soft metal conductor according to claim 39, wherein said first thickness of said first layer of metal is at least 100 nm and said second thickness of said second layer of metal is at least 600 nm.

43. (Original) A dual-step deposition method for making a soft metal conductor according to claim 39, wherein the second layer of metal is deposited by a chemical vapor deposition technique at a reaction temperature of not less than 300°C.

44. (Original) A dual-step deposition method for making a soft metal conductor according to claim 39, wherein the first layer of metal deposited by a physical vapor deposition process comprises large grain Cu alloyed with an element selected from C, B, N or an element from the Periodic Table Group IIIA, IVA, VA for improved wear and electromigration resistance.

45. (Original) A dual-step deposition method for making a soft metal conductor according to claim 39, wherein said second layer of metal deposited has a sheet resistance of not higher than 0.1 Ω/□.

46. (Original) A dual-step deposition method for making a soft metal conductor for use in an electronic device comprising the steps of:

depositing a first layer of metal by a chemical vapor deposition technique to a first thickness, and

depositing a second layer of metal by a technique selected from the group consisting of electroplating, electroless plating and high temperature physical vapor deposition process.

47. (Original) A dual-step deposition method for making a soft metal conductor according to claim 46, wherein said first metal layer deposited has an average grain size of not smaller than 0.3 μm

48. (Original) A dual-step deposition method for making a soft metal conductor according to claim 46, wherein said first layer of metal deposited by a chemical vapor deposition technique has a sheet resistance of not higher than 0.1 Ω/□.

49. (Original) A method for forming an interconnect in a logic or memory device by at least two levels of metals comprising the steps of:

depositing at least one layer of metal into a line or via hole of a material selected from the group consisting of Cu, Ag, Al, CuAg, CuAl, AgAl and CuAgAl, and

depositing a final layer of Cu having an average grain size of not smaller than 0.3 μm on top of said at least one layer of metal into said line or via hole.

50. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer comprising

depositing an amorphous barrier layer of refractory metal nitride or carbide into a line or via hole by a vapor deposition technique, and

depositing a layer of a conductive metal having an average grain size of not smaller than 0.3 μm on top of said amorphous barrier layer filling said line or via hole; And

further comprising depositing a hard dielectric layer between said amorphous barrier layer and said conductive metal.

53. (Previously presented) A method for forming an interconnect surround on three sides by an amorphous barrier layer according to claim 52, wherein said refractory metal in said refractory metal nitride or carbide is selected form the group consisting of W, Ta and Ti.

54. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52, wherein said conductive metal is selected from the group consisting of Cu, Ag, Al, CuAg, CuAl, AgAl and CuAgAl.

55. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52, wherein said vapor deposition technique is a chemical vapor deposition technique.

56. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52, wherein said refractory metal nitride is deposited by a chemical vapor deposition technique conducted at a reaction temperature about 300°C and about 400°C.

57. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52, wherein said refractory metal nitride is deposited by a sputtering technique by using a composite target.

58. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52 further comprising the step of annealing said amorphous barrier layer at a temperature of not lower than 400°C for at least ½ hour prior to the conductive metal deposition step.

59. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52 further comprising the step of depositing a seed layer of said conductive layer prior to the conductive metal deposition step.

60.-61. (Cancelled)

62. (Previously presented) A method for forming an interconnect surrounded at least on three sides by an amorphous barrier layer according to claim 52, wherein said hard dielectric layer is deposited of a material selected from the group consisting of fluorinated oxide and amorphous or porous oxide treated with SiH_4 or CH_4.

63.-66. (Cancelled)

67. (Previously presented) The method of claim 21 wherein said first layer of said soft metal is copper.

68. (Previously presented) The method of claim 67 wherein the layer thickness of the layer of said soft metal consisting of grains having a size of not more than 50 nm is not less than 600nm.

69. (Previously presented) The method of claim 21 wherein the layer thickness of the layer of said soft metal consisting of grains having a size of not more than 50 nm is not less than 600 nm.

70. (New) A method of making a soft metal conductor for use in a semiconductor device which comprises depositing a first layer of said soft metal containing grains having grain sizes sufficiently large so as to provide a substantially scratch-free surface upon polishing in a subsequent chemical mechanical polishing step and not less than 0.3μm; and further comprising depositing a layer of said soft metal containing grains having a grain size of not more than 50 nm and a layer thickness of not less than 400 nm prior to said deposition process of said first layer of soft metal so as to provide a substantially scratch-free surface upon polishing in a subsequent CMP step.

71. (New) A method according to claim 70, wherein said first soft metal layer has a thickness of at least 100 nm.

72. (New) A method according to claim 70 further comprising the steps of sequentially depositing a layer of Ti of less than 30 nm thick and a second layer of soft metal on top of said first soft metal layer such that the anti-electromigration property of said soft metal conductor is improved when said Ti layer is converted to $TiAl_3$ layer in a subsequent annealing process.

73. (New) A method according to claim 70, wherein said soft metal is selected from the group consisting of Al, Cu, Ag, CuAg, CuAl, AgAl, and CuAgAl.

74. (New) the method of claim 70 wherein said first layer of said soft metal is copper.

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75. (New) The method of claim 74 wherein the layer thickness of the layer of said soft metal containing grains having a size of not more than 50 nm is not less than 600 nm.

76. (New) The method of claim 70 wherein the layer thickness of the layer of said soft metal containing grains having a size of not more than 50 nm is not less than 600 nm.

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77. (New) The method of claim 21 which further comprises depositing said first layer and said second layer in openings located in low dielectric constant layer.

end

78. (New) The method of claim 70 which further comprises depositing said first layer and said second layer in openings located in low dielectric constant layer.